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Federal Communications Commission
425 12th Street, SW
Washington, D.C., 20065

Re: RM-11708

To the Commission:

As the designer of the protocol that became G-TOR, and of tactical modems that remain in use with military and intelligence organizations around the world, I have extensive international real world experience with trade-offs between bandwidth, modulation complexity, and symbol rates – all of which could (should) be selected based upon a measure of link quality. Different types of messaging may be best served by different "classes" of protocols and modulations – but in the modern world of DSP, a single modem system unit may support many protocols and modulation schemes. Archaic symbol rate and bandwidth limitations (which do not exist in the rest of the world) harm the ability of amateur experimenters to further the art and science.

Spectral efficiency in a narrow bandwidth (i.e., not spread spectrum) system relates to both time on air and bandwidth occupied. If we use a 300 bps/Baud FSK with 200 Hz (e.g., HF Packet) shift on HF, we are spectrally inefficient because the shift and Baud rate are not optimized and the tones are not well chosen. The result is poor detection at the receivers, leading to extended time on air (or failed communication after much time on air). Increasing the shift to 300 Hz, with well-chosen tones and in-band diversity, would improve the probability of detection -- leading to shorter time on air. That cannot be done today as the bandwidth required is 600 Hz. (Using a 150 Hz shift and well chosen tones would improve also, however the in-band diversity for these close-spaced tones is far less robust.)

By allowing maximum flexibility, the amateur community and/or vendors may develop a modem (i.e., system unit) that may adapt (or be adapted) to select a protocol and modulation that is efficient both in terms of bandwidth and time on the air for each type of messaging. The methodology that is "best" is not the same for all of these -- or even for the same type of message, on the same path, on different days.

A low bandwidth/low symbol rate protocol and modulation will be on air for a long period of time, even if no repeats are required. In the very common case of "selective fading" (multipath), a narrow bandwidth destroys our ability to use in-band diversity – which means that unnecessary repeats are required -- and this results in an even greater increase in time on air.

With sufficient bandwidth, we can eliminate the effects of selective fading on most viable circuits. In tests for military customers, I determined that simple FSK at rates as high as 600 Baud were very effective on HF in the presence of severe selective fading when the tone separation was equal to the Baud

rate. The modem produced uses a 600 Hz separation that is effective for 600, 300, 150, 75, and even 50 bps/Baud FSK. Our ultimate limitation was the requirement that tone frequencies be high enough to afford good detection (i.e., multiple cycles), and low enough to stay within the bandwidth "knees" of standard transmitter and receiver filters. Obviously, this modem cannot be used within a 500 Hz limit.

A higher symbol rate and/or higher bandwidth mode allows shorter transmission times. With a wider bandwidth, we may efficiently trade throughput for greater error correction by interleaving two or more copies of our data. While this cuts throughput, it also reduces or eliminates repeats, thus greatly reducing time on air.

Multiple low Baud rate tones may be sent in a single bandwidth, allowing a relatively high "air" data rate -- and offering the ability to employ in-band diversity to ensure correct reception. The symbol rate may be quite low, as all tones change in synchronization, but the data rate is the composite of all tones. This technique has been used on non-amateur frequencies for at least 40 years -- and other techniques have been proposed by amateurs that would extend the art and science.

I am a member of IEEE, was elected to Active Grade in Society of Motion Picture and Television Engineers for pioneering work in development and deployment of the first minicam systems, and spent seven years traveling the world with a cryptographic equipment manufacturer (as Senior Field Engineer and Product Development Engineer, among other titles). In that “life” I made our crypto equipment work on every conceivable type of HF/VHF/UHF radio, telephone, and satellite system used by military, diplomatic, and a few commercial users in 39 countries. I have held all classes of FCC licenses up to and including First Class Radiotelephone (converted to GROL) and Extra Class Amateur.

I fully support the simplification of rules to allow current technologies to be utilized, and eliminate the restrictions that have prevented amateur experimentation. I have no doubt that such experimentation will produce even more spectrally efficient and robust protocols.

Respectfully submitted,

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